Handling ROUGH RICE TO PRODUCE *HIGH GRADES*

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THE ENTIRE RICE INDUSTRY will profit by the production and marketing of better rough rice. A crop that is of uniformly high quality will bring greater returns to the producers, will facilitate domestic and foreign sales, and will create a stronger demand for American rice. Under such conditions, the market will be firmer and steadier.

High-quality milled rice cannot be produced from low-quality rough rice. Rough rice will not command high prices unless milled rice of high value can be produced from it.

Many circumstances that cause rough rice to bring a low price on the market can be partly corrected or entirely eliminated. Better seed and better cultural methods can be used. The crop can be cut when it is at the proper stage of maturity. Methods of shocking and of threshing can be improved. The threshed rice can be properly cleaned and artificially dried when necessary, and suitable storage facilities provided for the threshed grain.

Weeds and red rice reduce the yield and lower the value of the threshed rice. The elimination of weed seeds and red rice from seed rice and the eradication of weeds and red rice in the fields will bring the producer a larger financial return.

Other grains should not be mixed with rough rice. Such mixtures are troublesome in milling and reduce the value of the product.

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HANDLING ROUGH RICE TO PRODUCE HIGH GRADES

By W. D. SMITH, *senior marketing specialist, Bureau of Agricultural Economics*

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THE MARKET PROBLEM

RICE IS USED almost exclusively for human consumption. It goes to consumers largely in a form that makes it peculiarly sensitive to defects of quality. In the process of milling all defects must be removed if the highest competitive price is to be obtained. High-grade milled rice cannot be efficiently produced from low-grade rough rice.

The rice crop of the United States in 1935 amounted to 38,784,000 bushels of rough rice, produced chiefly in Louisiana, Texas, Arkansas, and California. Some rice is also produced in South Carolina, Georgia, Florida, Alabama, and Mississippi. A part of each crop is exported each year, and every year there are some imports of rice.

The annual per capita consumption of rice in the United States in 1935–36 was 5.4 pounds, which is materially less than that of any of the other cereal grains produced here. The secondary position of rice in the diet of the people, together with the large surplus for export, tends to create a market condition in which the prices to producers are dependent on what can be obtained for the finished product. The demand for the finished product is limited by custom rather than by comparative food value. The price for rough rice also varies with the cost of milling, which is intimately associated with the grades of rough rice. Rough rice cannot command a high price unless a high percentage of milled rice of high value can be produced from it.

The effective demand for whole-grain rice has much to do with the prices paid for rough rice. The grower must produce rough rice that will yield a high proportion of sound head milled rice if he is to get the best possible market price, for the quality and condition of rough rice governs, to a marked degree, the quality of the

milled rice and the cost of milling through mill yields. The factors that reduce the value of rough rice for milling purposes are largely within the control of growers.

CLASSES OF ROUGH RICE

Rough rice is classed[1] according to individual variety, except that when two or more varieties are practically identical as to size, shape, and other visible characteristics, they are placed in one class. Many of these classes of rice require separate treatment in the milling process, as milling efficiency is affected by a mixture of classes of rough rice of different lengths or sizes. In the beginning of the milling process the hulling stones are usually set to take the hulls off the longest kernels first. The shorter kernels escape at this time. The shorter kernels are then put through "return stones," which are set closer, so that the hulls of these kernels will be loosened, too. If there is only a small percentage of long-grain rough rice in a lot of short-grain rice, it is not practicable to set the first stones to take care of the few kernels of long-grain rice, as that would seriously delay the process of milling. In such a case the stones must be set to loosen the hulls on the longest kernels of the short-grain rice, and when this is done most of the long-grain rice is broken in the stones and the percentage of whole-kernels that can be made from the lot is reduced.

Difficulties caused by mixture of classes may be overcome by keeping the classes separate on the farm and in warehouses.

GRADES FOR ROUGH RICE

The United States standards divide each class of rough rice into seven grades. The first six grades are numbered, and the last is designated "Sample grade."

Rough rice, to meet the highest grade, must contain a large percentage of sound vitreous kernels, must have a low moisture content, and must be practically free from foreign seeds, other grains, red rice, and damaged kernels. Such rice will produce a high milling yield of whole kernels (head rice) of good quality and will therefore bring a good price on the market.

Rough rice produced in the Southern States is graded numerically for the factors, total damaged kernels, heat-damaged kernels, red rice, cereal grains, and rice of other classes. Rough rice produced in California is graded numerically for total damaged kernels, heat-damaged kernels, red rice, chalky kernels, total foreign material other than dockage, cereal grains and objectionable weed seeds, and rice of other classes.

Rough rice produced in the Southern States is also graded according to special grades, when applicable, for moisture, weed seeds, mud lumps, muddy kernels, chalky kernels, weevil infestation, musty odor, and milling quality. The special grades applicable to rough rice produced in California are for dockage, moisture, mud lumps, muddy kernels, weevil infestation, and musty odor.

[1] See the United States Standards for Rough Rice, effective Aug. 1, 1936, issued by the United States Department of Agriculture, and recommended for the grading and marketing of rough rice.

Rough rice that has a commercially objectionable foreign odor, or is sour, or heating, or hot, or otherwise of distinctly low quality is graded Sample grade.

COMMON DEFECTS OF ROUGH RICE

The common defects appearing in rough rice are: Red rice, weed seeds, other grains, small mud lumps, gravel, stones, other foreign material, thresher-broken kernels, damaged kernels, heat-damaged kernels, a high moisture content, and a low resistance to breakage. All these reduce the value of rice, principally because the quality and condition of the rough rice governs to a large extent the cost of milling, the milling yields, and the quality and condition of the milled rice that can be made from the rough rice.

It is possible to remove some of these defects from rice in milling, but when any one of them is present to a high degree in the rough rice it is difficult and often impossible to prevent its appearance in the milled rice. The commercial value of milled rice is based largely on its general appearance. Every reasonable precaution should be taken, therefore, by the grower to prevent the appearance of defects in the rough rice before it goes to the mill.

MILLING DIFFICULTIES CAUSED BY DEFECTS

The daily output of the mill is often greatly retarded because of the common defects in rice. Moreover, most of the foreign material removed from rough rice during its preparation for milling is worthless to the miller, and it costs money to remove it. Foreign material consisting of pieces of straw, sticks, large mud lumps, and the very large and very small weed seeds, can be removed comparatively easily from rough rice during the preparation for milling, but foreign material that is of about the same size and shape as the rice kernels is very difficult to separate from the milled rice. Some of the weed seeds have other characteristics that make them particularly difficult to eliminate.

Damaged kernels usually break more easily than sound kernels. They cause a milling loss because of a decrease in the yield of whole kernels and an increase in the yield of broken particles and by-products. In milled rice the various classes of broken rices generally sell at 1 to 4 cents a pound less than the whole kernel classes. Damaged kernels in the rough rice usually show in milled rice even when they do not break in milling.

False kernels, or kernels of rough rice that have little or no substance in the hulls, and very small, immature kernels are cleaned out of rough rice at the mill with the foreign material. They represent the same kind of loss to the miller as foreign material. Immature kernels that are large enough to stay in the rice during milling are often chalky in texture and are generally broken in the milling operations. Thresher-broken kernels and other broken-hulled kernels also reduce the milling value of rice.

Excessive moisture in rough rice causes the kernels to be soft, and more susceptible to breakage in milling. Damp bran and polish from rough rice of high moisture content often clogs some of the milling

machinery. The milled rice is also damp, and there is danger of its spoiling in storage.

Red rice is a troublesome factor in milling and each year is responsible for considerable loss to the industry. The seed of red rice is usually smaller than that of the commercial varieties grown in the United States; consequently, a large percentage of the rough rice kernels found in milled rice consists of red rice seeds. In practically all milled lots containing red rice there are some streaks of red bran left on the kernels.

When there is a large percentage of red rice in a lot the finished rice usually not only contains a large number of red-streaked kernels, but often the color of the finished lot as a whole is affected, because the red bran, coming in contact with the kernels of white rice during the milling operation, imparts to them a rosy or red appearance. As a rule, the kernels of red rice break more easily in milling than those of white rice and, as rough rice that contains red rice is usually milled close, in an effort to remove as much of the red bran as possible from the red rice kernels, the milling yield of whole-grain rice is generally reduced. This reduction is in proportion to the red rice contained in the lot.

HANDLING RICE TO AVOID COMMON DEFECTS

It is poor practice to spend time and money in producing a crop of rice and then lose part of the quality and profit through poor handling. Defects in rough rice can be reduced considerably or eliminated entirely by careful attention to details throughout the process of production—by the use of better seed, by better cultural methods, by harvesting the crop at the proper stage of maturity, by improved methods of shocking and threshing, by cleaning the threshed rice, and by providing suitable storage facilities for the threshed grain.

SEEDING

Rice is seeded in three ways, namely, by the end-gate seeder, the drill, and the airplane. In the Southern States practically all the rice is seeded by drills and end-gate seeders. In California broadcasting by airplanes and broadcasting by end-gate seeders are the most common methods.

Sowing with airplanes is popular because the work can be done so rapidly. The airplanes are equipped with hoppers from which the rice is fed into the current of air from the propeller. The seed is evenly distributed by having the planes fly back and forth and then across the field. The pilots are guided by flagmen on the ground.

When the airplane method is used, care must be taken to avoid mixing varieties, which may occur if the seed is permitted to fall into adjoining checkplots planted to a different variety of rice. Rice that is to be harvested by the windrow method should be sown broadcast rather than in rows as the stubble produced by the broadcasting affords a better support to the windrows.

NEED FOR BETTER SEED RICE

It is of primary importance that the rice used for seed be free of foreign seeds and red rice and that it show good germinating power.

Yet, only 4 lots of the seed rice being planted on 29 farms examined by investigators were free from weed seeds and red rice. All the others showed one or both kinds of seed. The quantity of these noxious weeds may seem to be small but the number planted on an acre is alarmingly large. The combined number of weed seeds and red rice being planted per acre on one farm totaled over 16,000.

During some planting seasons samples of seed rice have been obtained from different localities throughout the rice-producing areas of the South, and examined for red rice and weed seeds. The results are shown in table 1. Only about one-fourth of the samples were free of red rice. An average of 32 seeds of red rice per pound was found in these samples.

On the basis of sowing 80 pounds of seed per acre, this would mean that an average of 2,560 seeds of red rice were planted on each acre of ground along with the white rice. The seed rice being planted on 2 of the farms showed that approximately 11,000 seeds of red rice were being planted per acre; on 3 farms, between 5,000 and 10,000 red rice seeds; on 4 farms, between 2,000 and 5,000 seeds of red rice; and on the rest of the farms the samples indicated that red rice seeds varying in number from 0 to 2,000 were being planted per acre. Of the samples obtained, approximately 45 percent contained no weed seeds. The average number of weed seeds per pound for all the samples was 34, or 2,720 planted per acre.

The weed seeds commonly known as tall indigo, curly indigo, plantain, yellow foxtail, and kinghead predominated in these samples.

Considering both red rice and weed seeds as foreign seeds, 1 sample showed that 16,880 foreign seeds were planted per acre; 3 samples indicated that from 10,000 and 15,000 foreign seeds were being sown; 4 samples indicated that between 5,000 and 10,000 foreign seeds were being planted; 8 of them indicated the planting of between 2,000 and 5,000 foreign seeds; and the rest of the samples indicated that foreign seeds varying in number from 1 to 2,000 were being planted per acre.

TABLE 1.—*Weeds and red rice planted per acre with seed rice, based on 80 pounds of seed rice per acre*

Seed sample No.	Weed seeds	Red rice seeds	Total weed and red rice seeds	Seed sample No.	Weed seeds	Red rice seeds	Total weed and red rice seeds
	Number	*Number*	*Number*		*Number*	*Number*	*Number*
1	2,480	1,440	3,920	16	1,120	2,480	3,600
2	0	10,800	10,800	17	0	720	720
3	9,360	0	9,360	18	400	9,680	10,080
4	3,920	0	3,920	19	10,080	6,800	16,880
5	1,040	1,040	2,080	20	0	400	400
6	400	1,440	1,840	21	320	720	1,040
7	0	3,920	3,920	22	0	2,080	2,080
8	0	0	0	23	0	960	960
9	5,040	1,040	6,080	24	2,560	0	2,560
10	0	320	320	25	400	0	400
11	0	1,760	1,760	26	720	1,760	2,480
12	0	0	0	27	1,760	10,080	11,840
13	0	1,440	1,440	28	0	0	0
14	320	2,160	2,480	29	1,120	5,760	6,880
15	0	0	0				

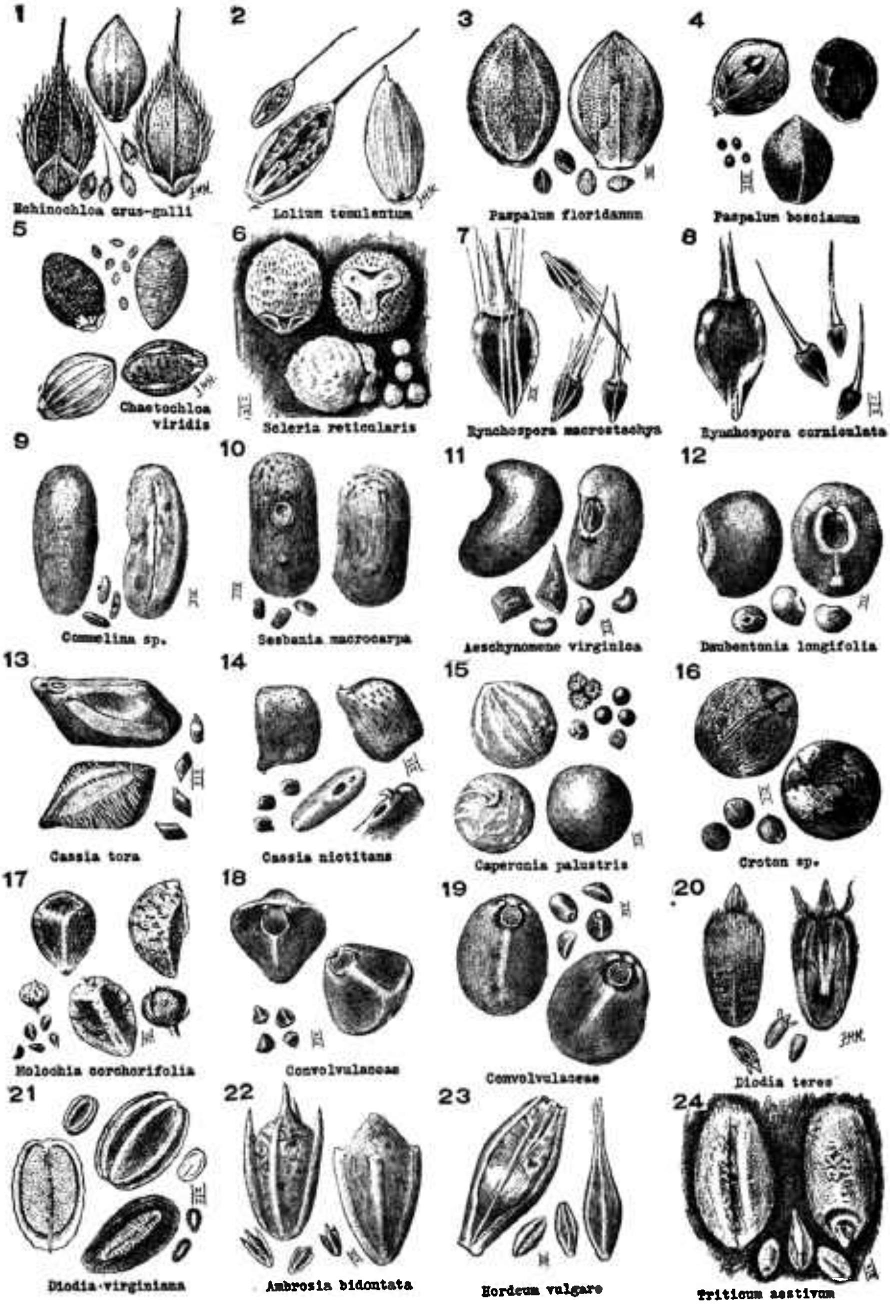

FIGURE 1.—Foreign seeds found in rice. The small-sized drawings of each kind of seed show the natural size of the seeds, and the enlarged drawings bring out the details.

The presence of red rice and weed seeds in threshed lots is often the direct result of planting such seeds with the seed rice. Many kinds of weed seeds are found in rough rice, but less than 25 occur commonly. The principal one is barnyard grass, which is prevalent in California. The light weight of this seed and its appendage or awn makes it hard to separate it from the rice. Representative kernels of 24 kinds of foreign seeds commonly found in rough rice are shown in figure 1. The 20 kinds of foreign seeds and grains found in rough rice, named in the order of their frequency, are: Barnyard grass, tall indigo, curly indigo, alligator head, plantain, oilseed, turtleback, low senna, Mexican weed, kinghead, spearhead, buck chess, large buttonweed, goats-beard, sensitive pea, morning-glory, coffeeweed, green foxtail, wheat, and barley. As the common names for these weeds vary in different localities, their botanical names are given in table 2.

TABLE 2.—*Common and botanical name of weed seeds found in rough rice*

Common name	Botanical name	Common name	Botanical name
Barnyard grass	*Echinochloa crus-galli*	Spearhead	*Rynchospora corniculata*
Tall indigo	*Sesbania macrocarpa*	Buck chess	*Lolium temulentum*
Curly indigo	*Aeschynomene virginica*	Large button-weed	*Diodia virginiana*
Alligator head	*Diodia teres*	Goats-beard	*Molochia corchorifolia*
Plantain	*Commelina* sp.	Sensitive pea	*Cassia nictitans*
Oilseed	*Caperonia palustris*	Morning-glory	Convolvulaceae
Turtleback	*Croton* sp.	Coffeeweed	*Daubentonia longifolia*
Low senna	*Cassia tora*	Green foxtail	*Chaetochloa viridis*
Mexican weed	*Scleria reticularis*	Wheat	*Triticum aestivam*
Kinghead	*Ambrosia bidentata*	Barley	*Hordeum vulgare*

NEED FOR GOOD CULTURAL METHODS

Improved cultural methods mean more rice of a higher grade. Good cultural methods require that the fields and levees be kept free of weeds and red rice at all times. It is not enough that the surface of the land be cleared of these pests just before planting, for many of these weed seeds and red rice kernels remain in the soil, and the fields are soon as badly infested as ever.

Unceasing efforts are required for thorough eradication. The custom of building high and narrow levees in the fields is rapidly falling into disfavor with progressive farmers. Such levees are too high and narrow to be planted to rice, and they serve as an excellent place for noxious weeds to thrive. Low, broad levees should be used and should be planted to rice like the remainder of the field. Weeds and red rice that grow in the fence corners, around the edge of the fields, and along irrigation canals should be cut several times each year to prevent the seed from maturing.

Red rice plants are sometimes found growing in the rice fields even when the seed rice may have been free of red rice. This is especially true where the same land is planted to rice year after year. It is usually because the red rice that grew in a previous crop scattered its seed before or during harvest and came up as volunteer plants. The red rice plants (fig. 2) are easily recognized after they have headed and, when they are not too numerous in the field, it pays to remove them by hand before the seeds mature. Cooperative experiments con-

ducted at the Rice Experiment Station, Crowley, La., show that in badly infested fields red rice may be controlled and eventually eradicated by growing the rice crop in rotation with the Biloxi soybean.

When a rotation of crops is practiced, care should be taken to prevent the mixture of other grains with rice. In rice-producing areas where wheat and barley are also raised, mixtures of these grains sometimes occur in the rice fields. It is not likely that barley and wheat seed, if planted with rice, will germinate and grow in those parts of the fields that are covered with water, but both will grow and mature on the levees and on other high spots. Fields that have been seeded to barley or wheat and, because of a poor stand of grain, are later planted with rice are especially likely to produced a mixed crop along the levees unless all plants of the cereal first planted are eradicated.

BAE 5460

FIGURE 2.—A red rice plant growing in a low spot of a field lying fallow. Note the shape of the panicles. The seed from this plant will shatter and cause the land to be infested with red rice the following season.

It is common practice in some sections where rice is cut by hand to cut the rice only, and to allow the weeds to remain standing in the field. They mature and scatter their seeds on the ground, so that the following crop contains more weeds than the previous one. This is an economic waste that costs rice producers heavily each year. Cutting and burning such weeds immediately after the rice is harvested will destroy the seeds and prevent them from infesting the following crop.

CUTTING AT THE PROPER STAGE OF MATURITY

Studies in the South have shown that the stage of maturity at which rice should be cut to obtain the best milling quality is when the moisture content of the kernels in the standing rice is between

23 and 28 percent. At that time the kernels in the upper portion of most of the heads are approaching the hard stage. Cutting should then proceed rapidly. When the crop is harvested before it reaches the proper stage of maturity there are many shriveled, chalky, lightweight kernels; when harvesting is delayed until the crop is overripe, the kernels become brittle and checked. The result in either case is that many more of the kernels are broken during threshing and milling than if the rice is cut at the right time, when the kernels are sound, plump, and well-manured.

HARVESTING

Four methods of harvesting rice are used in the United States—harvesting by hand, harvesting with a grain binder (fig. 3), harvesting with a header windrow and pick-up combine, and harvesting with a direct combine. The last method must be supplemented by artificially drying the threshed rice. All four methods are conducive to the production of high-grade rice, provided the crop is in the right condition when harvesting is done and proper care is used in the performance of the work.

FIGURE 3.—A binder at work in a rice field. Rice cut by this method should be put into comparatively small shocks. The straw and kernels must lose a large percentage of moisture before the grain will be cured; the loss of moisture cannot occur quickly unless the air is allowed to circulate through the shock.

When harvesting is done by hand, the rice is cut with a "reap" hook and is then spread in swaths on the stubble and later bound into sheaves by hand. By this method, harvesting may be done without bad effects while the rice is still wet with dew, provided it is allowed to lie on the stubble until it is dry, before being bound into sheaves.

When harvesting is done with a binder or the grain is windrowed with a header, the grain should be free of dew before being cut. At harvesttime rice straw normally contains a high percentage of moisture, and any additional moisture that may come from the dew and that cannot escape readily when the grain is bound into bundles or laid in windrows retards and sometimes prevents the natural curing of the grain in the shock or windrow. Green weeds contain ex-

cessive moisture, and if present in any considerable numbers, prevent to some extent the natural drying in the shock. If such rice is windrowed, the windrows should be light. If bundles of damp rice are shocked, the rice grains sometimes become moldy and heat-damaged.

Weather conditions are less important when the crop is directly combined because the rice is cured in an artificial drier. But it must be borne in mind that the greater the degree of moisture, the greater the amount of work the drier will have to do.

The labor situation, the weather, the nature of the soil in the fields, and the handling facilities determine the method of harvesting that is the most economical and practicable for each locality.

The hand method of cutting is popular in river sections of Louisiana where labor is cheap and plentiful and where soil or field conditions make it difficult to operate binders and other harvesting machines.

The binder method saves time and labor as compared with the hand method and is used in the United States to a greater extent than any other method.

The header-windrow method is used where economy is an important consideration and where weather conditions at harvesttime are favorable, but it is not popular in those sections where heavy rains may occur frequently while the rice is in the windrows.

The combine and artificial-drier method requires a greater initial expenditure for equipment and handling facilities, but high-quality rice is usually produced, as the crop can nearly always be cut at the proper stage of maturity, the rice is cured properly, the threshed rice is removed from the field as soon as it is cut, no damage comes from weather thereafter, and the rice is always in good condition when it is put into storage.

SHOCKING

Carelessness and improper shocking cause much damaged rice (fig. 4). When the crop is harvested with binders it is advisable to shock the bundles immediately, for they do not dry out readily on the ground, as they absorb moisture from the soil. When harvesting is done by hand, the grain that is cut in the morning should be left on the stubble at least until the dew dries (fig. 5). After the rice is bound into bundles immediate shocking is recommended.

Shocks should be located on the highest ground possible, because the high points are the first to dry after irrigations and they are the least likely to collect standing water from heavy rains. In many instances the bundles can readily be dumped from the binder near the levees, and if the levees are low and broad many of the shocks may be set upon this high ground. If rice is shocked in low places, water from heavy rains may get up into the bundles and damage the heads or it may saturate the straw so much that threshing is difficult. Rice bundles standing on wet ground also pick up mud, and threshed rice containing mud lumps sells at a discount.

Shocks that are well built and capped shed water, and the heads of such shocks are protected from the direct rays of the sun. Rice left exposed to the direct rays of the sun for a long time usually becomes brittle. This lowers its milling qualities and its price.

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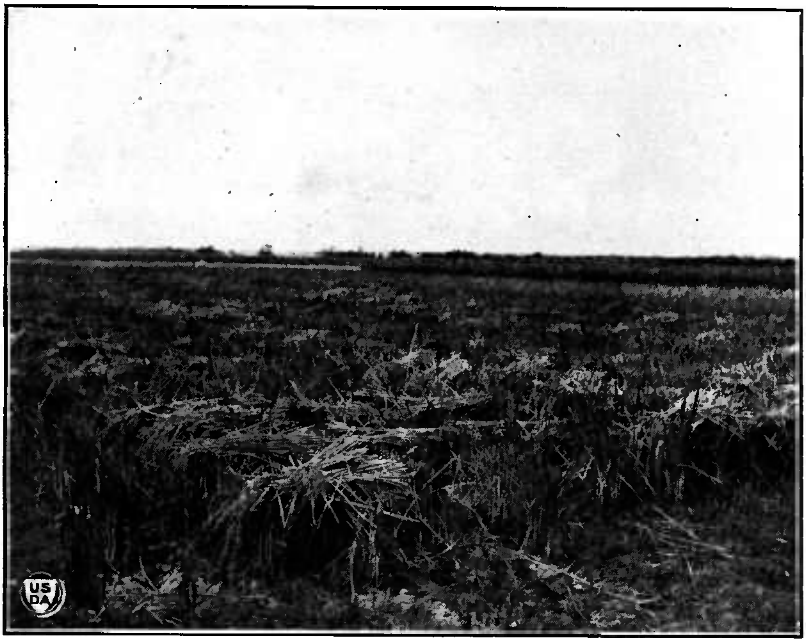
FIGURE 4.—This shock was poorly made and has twisted and fallen down. Practically all of the kernels are exposed. In rainy weather rice in shocks of this kind becomes wet and stained and is often badly smeared with mud.



BAE 7880

FIGURE 5.—Hand-cut rice curing on the stubble. Care should be taken to see that rice is all upon the stubble, as it may absorb moisture if allowed to remain in contact with damp or wet ground.

Different methods of shocking are used for rice harvested by hand than by binders. Rice cut by hand and allowed to lie on the stubble until most of the excess moisture has escaped from the straw and grain before binding can be put into slightly larger shocks than rice cut with binders (fig. 6), but such shocks should not be made larger than necessary, for good aeration at all times is beneficial to the grain.

When the rice is harvested with binders it is dangerous to put the bundles into large, compact shocks, for the rice contains practically the same moisture content as when it was cut and a large percentage of this moisture must escape before the grain will be in a suitable condition for threshing and milling. Small shocks facilitate this process. Rice improperly or insufficiently cured before threshing is usually soft and breaks easily, so it is of poor milling quality.


BAE 5099

FIGURE 6.—A well-made shock of hand-cut rice. The shock is made very compact. Well-cured rice may be shocked in this way without great danger, but damp rice requires more aeration and should be put into smaller shocks.

The following method of building shocks for rice harvested with a binder usually gives satisfaction: Two bundles are set firmly on the ground with the butts about 1 foot apart, and the heads are pressed firmly together. Two more bundles are then set in the same way in a position at right angles to the first pair, bringing the heads of all four bundles together. One bundle is then placed in each of the four spaces between the first two pairs of bundles. This makes, in all, eight bundles standing on the ground. Four bundles are used in capping the shock. The butts of all cap sheaves are spread and the first one is so placed that the heads lie on the top of the shock and the butt end hangs well over the east side of the shock. The next bundle is placed so that the butt end hangs over the north side of the shock, the next bundle so that the butt end hangs over the west side of the shock, and the last bundle is so placed that it covers the heads of the other cap sheaves and its butt end hangs over the south side of the shock so that the

heads of the sheaf will be protected from the sun (fig. 7). The entire shock should be solidly built and the caps firmly placed so that they will not be blown off by wind. This form of shock, if well made, sheds water during rainy weather, protects the grain from the direct rays of the sun, and permits thorough aeration.

CURING

The length of time that rice may be safely allowed to stay in the shock before being threshed depends largely on circumstances. In most cases it is profitable to allow this curing to proceed for at least 10 days or 2 weeks. If the rice is properly shocked, it cures well, threshing is made easy, and the threshed grain is in good condition

BAE 17920D

FIGURE 7.—A well-made shock of binder-cut rice. The bundles are set up firmly and in such a way as to allow a circulation of air through the shock. The cap bundles are so placed that little of the grain is exposed. The heads of the top sheaf hang over the north side of the shock.

for storing and brings a good price when sold on the market. On the other hand, if threshing is done too soon the straw is tough and the seed does not thresh off the straw easily and is likely to be soft and not in suitable condition for storage or milling. Prematurely threshed rice contains an excess of moisture and is likely to spoil in storage.

If wet bundles are hauled they should not be threshed as soon as brought in. If they are put into the separator immediately some of the rice is usually lost because the straw is tough and does not thresh well, and much of the wet straw breaks up and goes into the threshed grain. These small pieces of wet straw cause some damage to threshed rice in storage. Kernels in a damp or wet spot in stored threshed rice are likely to begin to germinate and cause the rice to become musty or to heat. If the percentage of moisture in the rice in such wet spots is comparatively low the damage is usually confined

to a small number of bags, but if there are a great many such wet spots and each has a relatively high moisture content, entire lots of rice are likely to spoil. Such out-of-condition rice is of low grade, and brings a low price when sold on the market.

If bundles are wet but not muddy, it is a good plan to spread them out on a tarpaulin at the threshing separator until dry. They may then be threshed without fear of lowering the market value or endangering the keeping qualities of the threshed rice. But if any of the bundles have either wet or dry mud clinging to the butts, all of the muddy part of the straw should be cut off before the bundles are threshed. If some of the bundles have mud on both the heads and butts it is best to thresh them separately and store the grain separately. This makes the greater part of the grain safer for storage purposes. All the work of conditioning bundles before threshing should be done on high ground and preferably at the separator.

THRESHING THE GRAIN

A great deal of rice is lost every season and the quality of much of that saved is materially lowered by improper and careless handling of the threshing separator. The separator should be put in good repair before the threshing season begins and should be kept in good running order throughout the season. Efficient threshing cannot be done with a machine that is not working properly. An even feed of rice into the machine should be maintained whenever the separator is running. With too heavy feeding it is not possible to clean the rice thoroughly, and some is likely to be carried over with the straw into the straw stack. If the feed is too light it often results in the presence of a great many cracked kernels in the threshed grain and a reduced market value of the rice. Feeding a separator spasmodically, heavily at times and lightly at other times, brings a combination of undesirable results.

It is essential that as much as possible of the foreign material in rice be removed in threshing. It is advisable to inspect the rice from time to time to see how it is running with reference to cleaning and breakage of kernels and to catch some of the straw from the stacker at intervals to see if any rice is being lost in the straw pile.

The windrow pick-up method and the direct-combine and artificial-drier method are extensively used in California. The windrow pick-up method permits the use of the combine without requiring the use of a mechanical drier to cure the rice. Two types of headers are commonly used to cut and windrow the rice, namely, push swathers, which are usually of local construction, and pull swathers, of either local or commercial make.

With the windrow pick-up method, it is necessary to allow enough space between the first windrows and the levees for the operation of the combine. Push swathers make the first cut around the check. The size of the swath ranges from 8 to 16 feet. In California the 12-foot swath is the most popular. A cut of this width permits the rice to dry uniformly under average conditions.

Swathed rice is permitted to cure for from 1 to 7 days, depending on the weather. The rice should be threshed as soon as the moisture content has been reduced to the right point.

With the combine and artificial drier method, the rice is cut and threshed in one operation (fig. 8). The combines range from standard commercial machines pulled by tractors to self-propelled ones assembled by the individual farmer. Some of the combines are equipped with push swathers and others with side swathers. Unless a combine has a push swather, the check should be opened with a push swather.

In California it is estimated that approximately 15 percent of the rice is directly harvested with combines and is artificially dried. This method is growing in popularity, because when properly employed rice of high grade and exceptional milling quality can be produced. Rice directly harvested with a combine is normally of high moisture content, so it should be artificially dried without delay to avoid heating or fungous damage while it is in storage. To preserve the quality

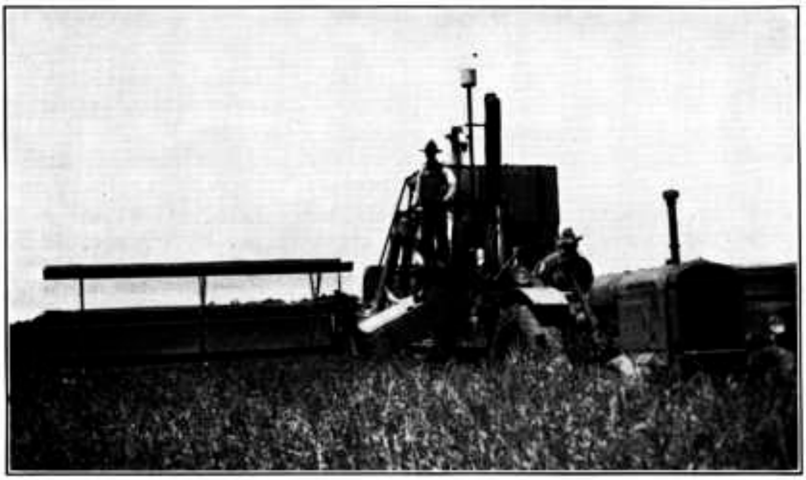


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FIGURE 8.—Harvesting and threshing rice with a combine. Rice harvested directly with a combine must be artificially dried to reduce its moisture content for safe storage and for milling.

of the rice that is artificially dried, temperatures of between 90° and 100° F. are used. Excessively high temperatures and too rapid drying must be guarded against.

MECHANICAL MIXING OF KINDS TO BE AVOIDED

Care must be taken at threshing time to see that all sacks for rough rice are free of other seeds. New sacks are nearly always clean. If old sacks are used they should be thoroughly recleaned. Any seed other than rice that may be contained in a sack is readily detected with a trier when the rice is sampled, and the presence of even a small percentage of other seeds in a sample tends to lower the value of the lot. It may be that the "other cereal grains" found in the sample are only the few kernels that stuck to the inside of the sacks, but unless all sacks are opened and the contents carefully examined there is no way of knowing whether the sample drawn with a trier is truly representative of the lot or not, so that such rice is likely to sell

at a discount. This uncertainty may be eliminated by the use of absolutely clean sacks.

When more than one kind of grain is stored in a warehouse, care should be taken to avoid mixtures. In some sections rice is often stored alongside other grains, and mixtures discovered later are the result of careless handling in storage. Sacks sometimes burst in the warehouse, and when the rice is swept up and put into new sacks kernels of other grains lying on the floor may be put in the sacks with the rice.

Occasionally sacks of barley or wheat are loaded into a car with a shipment of rice, and these grains are at times inadvertently "cut in" with the rice at the mill. The mixture lowers the value of the rice materially. Cars used for shipping rough rice, whether in sacks or in bulk, should be thoroughly cleaned before being loaded so that all grain left on the floor and around the sides will be removed.

CLEANING ROUGH RICE

Rough rice should be thoroughly cleaned for either storing or marketing. Running rough rice through a cleaning machine has several advantages in addition to the removal of the foreign material. When the rice contains a high percentage of moisture, the aerating it receives in cleaning usually reduces the moisture content and lessens the chances of its heating or becoming musty. If the kernels have begun to heat or have become musty the cleaning machine can be used to advantage in putting the rice into good condition. Recleaning also helps to retard the destruction of the kernels by weevils, as many of the weevils are blown out of the rice by the air blast and others pass through the sieves. If weevil-cut kernels are present, most of the worst ones are removed in the cleaning operation.

Seed rice should always be thoroughly recleaned before planting. A better stand is obtained if the seed rice is free of weed seeds and, what is still more important, the crop will have fewer foreign seeds when it is threshed.

The principal features of an efficient rice-cleaning machine are large-mesh screens for removing the large forms of foreign material, a fan for blowing out the lightweight seeds, straw, dust, and other light matter, and small-mesh sieves for removing the broken grains and small weed seeds.

FARM STORAGE

It is poor practice to take good care of the crop to the time when the threshed rice is ready for storage and then to allow its quality to become lowered by neglecting to provide suitable storage. The way of handling the rice at this time may decide whether there will be a profit or loss on the crop.

There are two methods of storing rough rice—bag storage and bulk storage. Apparently either method gives satisfaction under normal conditions if care is used. Most of the crop is handled in bags. Regardless of the way in which the rice is to be handled, it is essential for best results that good storage space be provided and made ready for use before the crop is threshed.

Bags of rice are often piled in the open near the threshing separator and left there for an indefinite length of time insufficiently pro-

tected from the weather (fig. 9). This is a costly practice. When, for some unavoidable reason, it is absolutely necessary to store the sacks in the open, the risk will be much less if poles are first laid

BAE 5462B

FIGURE 9.—Sacks of rice left in the field with practically no protection from the weather. When it is necessary to leave rice in the field temporarily it should be stacked up off the ground and covered with tarpaulins or some other waterproof material.

BAE 6721

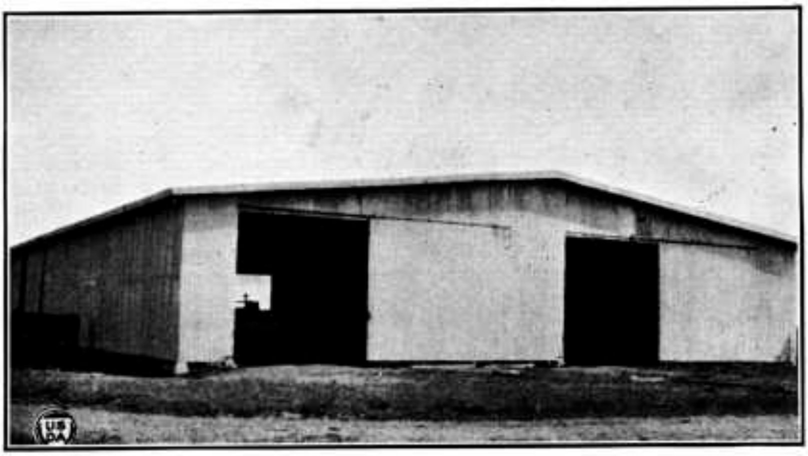
FIGURE 10.—Damp rice stacked in the open during favorable weather to prevent spoilage. This method of stacking permits a good circulation of air. Poles may be used instead of timbers. During damp weather the sacks should be covered with a good rainproof tarpaulin.

parallel to each other on the ground and then another lot of rails laid crosswise on top of these, so the bottom bags will be raised several inches from the ground (fig. 10). The finished pile of bags should

be protected from the sun and rain with a covering that will shed water.

It is always much safer to store the sacks of rice in a shed or warehouse that has a good roof, a dry floor, and good ventilation (fig. 11). Ventilation of the storehouse walls should be so arranged that rain cannot be blown in during stormy weather. The way in which sacks of rough rice should be piled to prevent spoilage in storage is governed by the condition of the grain. It is not likely that well-cured rice, free from foreign material, will go out of condition if it is stored compactly, but great care must be used with rice that either has a high moisture content or contains damp foreign material. Such rice is much more likely to become musty or hot and should be stored in a way that will permit thorough aeration.

It is a good plan to stack sacks of damp rice on poles or boards to keep the bottom bags off the floor and to leave open spaces between the tiers of sacks for air circulation. If rice is exceedingly damp,



BAE 5083

FIGURE 11.—A shed erected on a farm to provide storage space for sacked rice at threshing time and to protect farm implements when no rice is on hand.

the sacks should be stood on end separately, or the rice should be taken out of the sacks and spread in a thin layer on a dry floor and turned over occasionally by hand shoveling. Proper care of damp or wet rice sometimes turns what would otherwise be a loss into a profit. Good ventilation of rice in storage prevents losses from spoilage and aids the escape of excess moisture from the rice, thus hardening the kernels to some extent and increasing the milling value of the rice.

BULK STORAGE

Granaries, bins, and elevators used for bulk storage should be built so that the rice will be protected from the weather and still be well-ventilated (figs. 12 and 13). Ventilators that permit circulation of air through the grain can be simply constructed and yet lower the risk of grain heating. Such ventilators may consist merely of openings cut in the bottoms of the bins and covered with strong, fine-mesh

wire to prevent the leakage of rice. For this type of ventilator, it is advisable first to cover the openings with strong wire of any mesh to support the weight of the grain and then to cover this wire with a

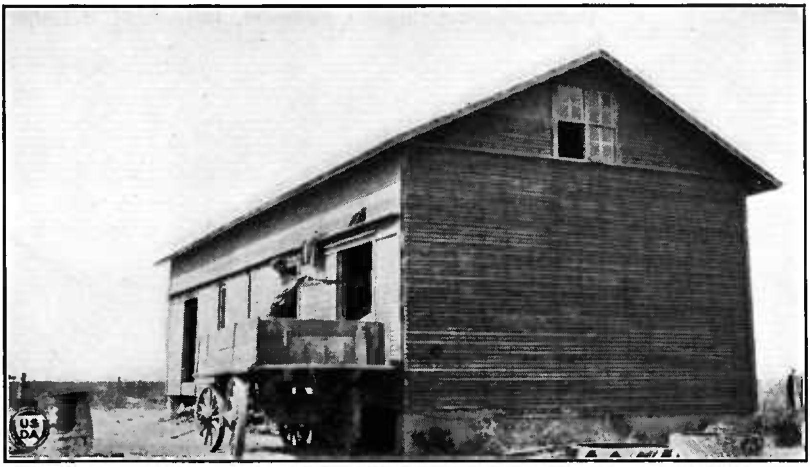


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FIGURE 12.—A wooden granary used for bulk storage of rice on the farm. Each of the four doors opens into a separate bin, which provides for the storage of four different kinds or grades of rice. The bin partitions are only as high as the eaves; in each end of the granary, windows in the gable allow ventilation.

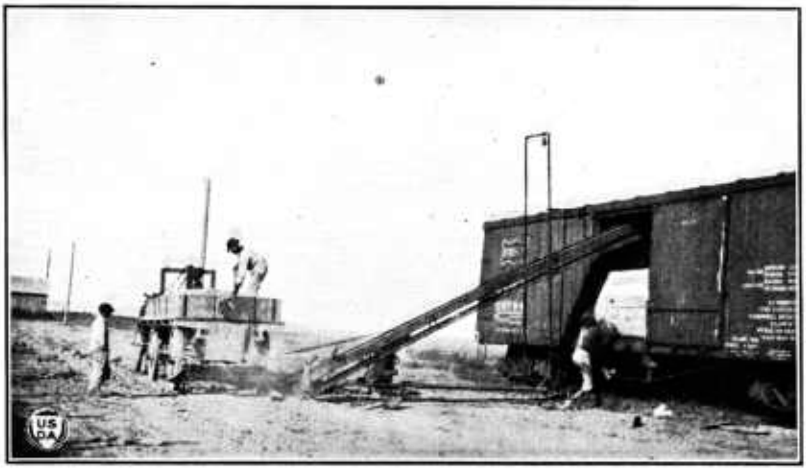
BAE 5420B

FIGURE 13.—One type of steel granary used for the storage of bulk rough rice. Rice to be stored in this way should be well-cured before being stored.

fine-mesh screen that will not let the kernels pass through. The number and size of the openings in the floors depend chiefly on the size of the bins and the construction of the floors. It is advisable to have as many openings as possible and to have them as large as is

possible without weakening the floor. It is best, as a rule, not to have any opening closer than 3 feet to the edge of the building if the space under the bin is not enclosed, otherwise dampness may enter with the air during wet weather, which would be bad for the rice. Whenever possible, the space under the bin should be enclosed in such a way as to prevent the entrance of outside air in rainy weather.

To insure circulation of air through the rice, openings should be provided at the tops of the bins. In buildings that have gable roofs and in those in which the bin partitions are not higher than the eaves, it is best to make the top openings in the ends of the building. These openings may be made weatherproof and still allow the air to pass if louver boards are placed in them. These boards have enough overlap to prevent the entrance of rain. The space between



BAE 5463

FIGURE 14.—Loading bulk rice into a car for shipment at a country siding where there is no elevator. The loading apparatus is driven by a small gasoline engine and can also be used for putting rice into granaries or for transferring rice from one storage bin to another.

boards should not exceed 3 inches. In buildings where it is not possible to construct such top openings a cupola on top of the roof will serve practically the same purpose if provided with louvers.

In bins constructed in these ways, when not more than 8 to 12 feet in depth, there is a natural circulation of air which is usually sufficient to keep rice in good condition, but if means for forcing a draft through the grain can be devised economically it is highly desirable. This has been done by enclosing the space under the bin except for one opening, and placing a fan of some kind in this opening. Forced aeration is especially beneficial to damp rice.

Damp bulk rice should be stirred frequently to prevent heating. This may be done readily in elevators where there is machinery for transferring the grain from one bin to another, but in farm storage it is usually more difficult. However, the elevating machinery with which the grain is put into the tanks or granaries can sometimes be utilized to advantage in transferring the rice (fig. 14). It is well

to put a blast of cool air on the rice at the time of transfer to cool it if it has begun to heat. Aeration can often be accomplished by dropping or "running" the rice through the driveway of a granary, or by transferring it from bin to bin or from tank to tank in the open air. Rice that is cool and in good condition should never be run in humid air or in air that is warmer than the rice. In the first instance, the rice is likely to take on moisture from the humid air; and, in the second, the temperature of the rice is raised.

MOISTURE CONTENT FOR SAFE STORAGE

The moisture content of rough rice is a prime factor in determining its keeping qualities in storage. The temperature and the humidity of the air also play an important part. A moisture content that may be safe for storage under some conditions may not be safe under other conditions. Therefore, the maximum moisture content for safe storage varies with the conditions. Experience has shown that a moisture content of 14 percent usually is the maximum limit for safe storage of rough rice. This percentage may be too high for safekeeping in storage for long periods under unfavorable conditions. On the other hand, rough rice with a moisture content exceeding 14 percent may sometimes be stored with safety if the conditions are favorable.

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